41039 Boyce Road
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Radio Test Report

FCC Part 90 and RSS-119
(406.1 MHz to 470 MHz)

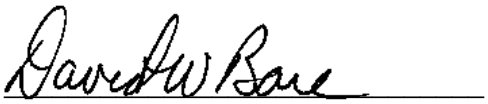
Model: LN400

ISEDC CERTIFICATION #:	101D-LN400
FCC ID:	E5MDS-LN400
COMPANY:	GE Digital Energy - MDS 175 Science Pkwy Rochester, NY 14620
TEST SITE(S):	National Technical Systems 41039 Boyce Road. Fremont, CA. 94538-2435
PROJECT NUMBER:	PR147289
REPORT DATE:	October 28, 2021
FINAL TEST DATES:	October 8, 11, 20, 22 and 27, 2021
TOTAL NUMBER OF PAGES:	41

A2LA ACCREDITED
Testing Cert #0214.26

VALIDATING SIGNATORIES

PROGRAM MGR



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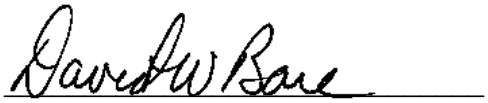

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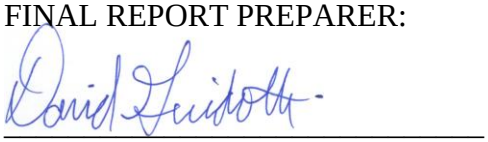

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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	October 28, 2021	First release	

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SCOPE

Tests have been performed on the GE Digital Energy - MDS model LN400, pursuant to the relevant requirements of the following standard(s) in order to obtain device certification against the regulatory requirements of the Federal Communications Commission and Innovation Science and Economic Development Canada.

- Code of Federal Regulations (CFR) Title 47 Part 2
- RSS-Gen Issue 5, April 2018
- CFR 47 Part 90 (Private Land Mobile Radio Service) Subpart I
- RSS-119, Issue 12, May 2015 (Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz)

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems test procedures:

ANSI C63.26:2015
ANSI TIA-603-E March 2016
FCC KDB 971168 Licensed Digital Transmitters

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Innovation Science and Economic Development Canada performance and procedural standards.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

National Technical Systems is accredited by the A2LA, certificate number 0214.26, to perform the test(s) listed in this report, except where noted otherwise.

The test results recorded herein are based on a single type test of the GE Digital Energy - MDS model LN400 and therefore apply only to the tested sample. The sample was selected and prepared by Christopher Hughes of GE Digital Energy - MDS.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA and Canada, the device requires certification.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of GE Digital Energy - MDS model LN400 complied with the requirements of the standards and frequency bands declared in the scope of this test report.

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS

FCC Part 90 and RSS-119

FCC	Canada	Description	Measured	Limit	Result
Transmitter Modulation, output power and other characteristics					
§2.1033 (c) (5) § 90.35	RSS-119	Frequency range(s)	406.1-470 MHz	406.1 – 470 MHz	Pass
§2.1033 (c) (6) §2.1033 (c) (7) § 2.1046 § 90.205	RSS-119	RF power output at the antenna terminals	19.6 - 41.3 dBm	Determined based on License	Pass
§2.1033 (c) (4) § 2.1047 § 90.210	RSS-119	Emission types	D1D		
		Emission mask C, D, E	Within mask	Shall be within mask	Pass
	RSS-119	Emissions mask Y	Within mask	Shall be within mask	Pass
§90.221	-	Adjacent Channel Power	Below limits	§90.221(b)(1) table	Pass
§ 2.1049 § 90.209	RSS-GEN 6.7 RSS-119	Occupied Bandwidth	5.1 kHz 10.4 kHz 10.7 kHz 17.1 kHz 21.5 kHz	6.0 kHz 11.25 kHz 11.25 kHz 20 kHz 22 kHz	Pass
§ 90.214	RSS-119	Transient Frequency Behaviour	No change from original filing		
Transmitter spurious emissions					
§ 2.1051 § 2.1057	RSS-119	At the antenna terminals	All < -25 dBm	-25.0 dBm	Pass
§ 2.1053 § 2.1057	RSS-119	Field strength	-28.8 dBm @ 1410 MHz	-25.0 dBm	Pass
Other details					
§ 2.1055 § 90.213	RSS-119	Frequency stability	No change from original filing		
§ 2.1093	RSS-102	RF Exposure	Complies, see separate exhibit		
§2.1033 (c) (8)		Final radio frequency amplifying circuit's dc voltages and currents for normal operation over the power range	No change from original filing		
Note 1 Pass/Fail criteria defined by standards listed above.					

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2) and were calculated in accordance with NAMAS document NIS 81 and M3003.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF frequency	Hz	25 to 7,000 MHz	1.7×10^{-7}
RF power, conducted	dBm	25 to 7,000 MHz	± 0.52 dB
Conducted emission of transmitter	dBm	25 to 40,000 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 40,000 MHz	± 2.5 dB
Radiated emission (field strength)	dBμV/m	25 to 1,000 MHz 1 to 40 GHz	± 3.6 dB ± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The GE Digital Energy - MDS model LN400 is an industrial data radio module operating in 406.1-470 MHz bands using both FSK and QAM modulations. Since the EUT could be placed in any position during operation, the EUT was treated as table-top equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 10.0-60.0 Volts DC, 2.5 Amps max.

The sample was received on October 8, 2021 and tested on October 8, 11, 20, 22 and 27, 2021. The following samples of the EUT were used during testing:

Company	Model	Description	Serial Number	FCC ID
GE MDS	LN400	Industrial Radio Module	3696417	E5MDS-LN400
GE MDS	LN400	Industrial Radio Module	3696416	E5MDS-LN400

OTHER EUT DETAILS

The following EUT details should be noted: The host product in which this product will be used "Orbit" is rated from -40°C to +70°C, 10-60 VDC input

ENCLOSURE

The EUT does not have an enclosure as it is intended to be installed in a complete product. The PCB measures approximately 11 cm wide by 3.8 cm deep 0.6 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at National Technical Systems.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Configuration #1

Company	Model	Description	Serial Number	FCC ID
Hewlett Packard	6024A	Power Supply	2430A-03013	-
Agilent	E3610A	Power Supply	MY40011740	-

Configuration #2

Company	Model	Description	Serial Number	FCC ID
Agilent	E3610A	Power Supply	MY40011740	-

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
hp	Probook 6570b	Laptop	5CB2480TRQ	-

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Com1	Laptop	Multiwire with adapter	Unshielded/Shielded	2

EUT OPERATION

Configuration #1: During emissions testing the EUT was programmed to transmit continuously using TEST PRBS command at the selected frequency and power level or was set to receive at the desired frequency.
Configuration #2: During emissions testing the EUT was programmed to transmit continuously using KEYR command at the selected frequency and power level or was set to receive at the desired frequency.

TESTING

GENERAL INFORMATION

Antenna port measurements were taken at the National Technical Systems test site located at 41039 Boyce Road, Fremont, CA 94538-2435.

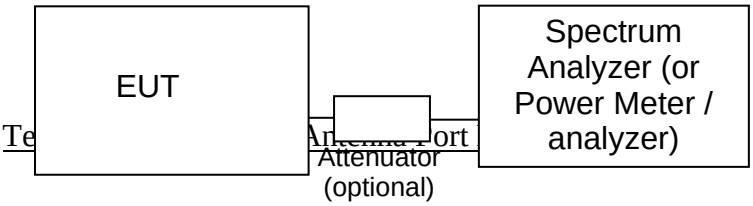
Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 6.2 of RSS-GEN, NTS has been recognized as an accredited test laboratory by the Commission and Innovation, Science and Economic Development Canada. A description of the facilities employed for testing is maintained by NTS.

Site	Company / Registration Numbers		Location
	FCC	Canada	
Chamber 5 & 7 and Lab 4b	US1031	2845B (Wireless test lab #US0027)	41039 Boyce Road Fremont, CA 94538-2435

ANSI C63.4 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Results from testing performed in the chambers have been correlated with results from an open area test site above 30 MHz and with an open field site below 30 MHz. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4.

RF PORT MEASUREMENT PROCEDURES

Conducted measurements are performed with the EUT's rf input/output connected to the input of a spectrum analyzer, power meter or modulation analyzer. When required an attenuator, filter and/or dc block is placed between the EUT and the spectrum analyzer to avoid overloading the front end of the measurement device. Measurements are corrected for the insertion loss of the attenuators and cables inserted between the rf port of the EUT and the measurement equipment.



For devices with an integral antenna the output power and spurious emissions are measured as a field strength at a test distance of (typically) 3m and then converted to an eirp using a substitution measurement (refer to RADIATED EMISSIONS MEASUREMENTS). All other measurements are made as detailed below but with the test equipment connected to a measurement antenna directed at the EUT.

OUTPUT POWER

Output power is measured using a power meter and an average sensor head, a spectrum analyzer or a power meter and peak power sensor head as required by the relevant rule part(s). Where necessary measurements are gated to ensure power is only measured over periods that the device is transmitting.

Power measurements made directly on the rf power port are, when appropriate, converted to an EIRP by adding the gain of the highest gain antenna that can be used with the device under test, as specified by the manufacturer.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS-GEN. The measurement bandwidth is set to be at least 1% of the instrument's frequency span.

CONDUCTED SPURIOUS EMISSIONS

Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode measurements). Where the limits are expressed as an average power the spectrum analyzer is tunes to that frequency with a narrow span (wide enough to capture the emission and its sidebands) and the resolution and video bandwidths are adjusted as required by the reference measurement standards. For transmitter measurements the appropriate detector (average, peak, normal, sample, quasi-peak) is used when making measurements for licensed devices. For receiver conducted spurious measurements the detector is set to peak.

TRANSMITTER MASK MEASUREMENTS

The transmitter mask measurements are made using resolution bandwidths as specified in the pertinent rule part(s). Where narrower bandwidths are used the measurement is corrected to account for the reduced bandwidth by either using the adjacent channel power function of the spectrum analyzer to sum the power across the required measurement bandwidth. The frequency span of the analyzer is set to ensure the fundamental signal and all significant sidebands are displayed.

The top of the mask may be set by the total output power of the signal, the power of the unmodulated signal or the peak value of the signal in the reference bandwidth being used for the mask measurement.

RADIATED EMISSIONS MEASUREMENTS

Receiver radiated spurious emissions measurements are made in accordance with ANSI ANSI C63.26 by measuring the field strength of the emissions from the device at a specific test distance and comparing them to a field strength limit. Where the field strength limit is specified at a longer distance than the measurement distance the measurement is extrapolated to the limit distance.

Transmitter radiated spurious emissions are initially measured as a field strength. The eirp or erp limit as specified in the relevant rule part(s) is converted to a field strength at the test distance and the emissions from the EUT are then compared to that limit. Emissions within 20dB of this limit are the subjected to a substitution measurement.

All radiated emissions measurements are performed in two phases. A preliminary scan of emissions is conducted in either an anechoic chamber or on an OATS during which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed across the complete frequency range of interest and at each operating frequency identified in the reference standard. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. Initial scans are made using a peak detector (RBW=VBW) and using scan rates to ensure that the EUT transmits before the sweep moves out of each resolution bandwidth (for transmit mode).

During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit. For transmitter spurious emissions, where the limit is expressed as an effective radiated power, the eirp or erp is converted to a field strength limit.

Final measurements are made on an OATS or in a semi-anechoic chamber at the significant frequencies observed during the preliminary scan(s) using the same process of rotating the EUT and raising/lowering the measurement antenna to find the highest level of the emission. The field strength is recorded and, for receiver spurious emissions, compared to the field strength limit. For the final measurement the appropriate detectors (average, peak, normal, sample, quasi-peak) are used. For receiver measurements below 1GHz the detector is a Quasi-Peak detector, above 1GHz a peak detector is used and the peak value (RB=VB=1MHz) and average value (RB=1MHz, VB=10Hz) are recorded.

For transmitter spurious emissions, the radiated power of all emissions within 20dB of the calculated field strength limit are determined using a substitution measurement. The substitution measurement is made by replacing the EUT with an antenna of known gain (typically a dipole antenna or a double-ridged horn antenna), connected to a signal source. The output power of the signal generator is adjusted until the maximum field strength from the substitution antenna is similar to the field strength recorded from the EUT. The erp of the EUT is then calculated.

INSTRUMENTATION

An EMI receiver as specified in CISPR 16-1-1 is used for radiated emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 7000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary.

For measurements above the frequency range of the receivers and for all conducted measurements a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis.

Measurement bandwidths for the test instruments are set in accordance with the requirements of the standards referenced in this document.

Software control is used to correct the measurements for transducer factors (e.g. antenna) and the insertion loss of cables, attenuators and other series elements to obtain the final measurement value. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are exported in a graphic and/or tabular format, as appropriate.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the EUT antenna port or receiving antenna and the test receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A combination of biconical, log periodic or bi-log antennas are used to cover the range from 30 MHz to 1000 MHz. Broadband antennas or tuned dipole antennas are used over the entire 25 to 1000 MHz frequency range as the reference antenna for substitution measurements.

Above 1000 MHz, a dual-ridge guide horn antenna or octave horn antenna are used as reference and measurement antennas.

The antenna calibration factors are included in site factors that are programmed into the test receivers and instrument control software when measuring the radiated field strength.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.
Table mounted devices are placed on a non-conductive table at a height of 80 centimeters above the floor. Floor mounted equipment is placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material up to 12 mm thick if the device is normally used on a non-conductive floor. The EUT is positioned on a motorized turntable to allow it to be rotated during testing to determine the angel with the highest level of emissions.

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS - CONDUCTED SPURIOUS EMISSIONS

Measurements are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

R_r = Measured value in dBm
S = Specification Limit in dBm
M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH

Measurements of radiated field strength are compared directly to the specification limit (decibel form). The receiver and/or control software corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor is sued when measurements are made at a test distance that is different to the specified limit distance by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB
D_m = Measurement Distance in meters
D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS –RADIATED POWER

The erp/eirp limits for transmitter spurious measurements are converted to a field strength in free space using the following formula:

$$E = \frac{\sqrt{30\ P\ G}}{d}$$

where:

E = Field Strength in V/m
P = Power in Watts
G = Gain of isotropic antenna (numeric gain) = 1
D = measurement distance in meters

The field strength limit is then converted to decibel form (dBuV/m) and the margin of a given emission peak relative to the limit is calculated (refer to *SAMPLE CALCULATIONS –RADIATED FIELD STRENGTH*).

When substitution measurements are required (all signals with less than 20dB of margin relative to the calculated field strength limit) the eirp of the spurious emission is calculated using:

$$P_{EUT} = P_S - (E_S - E_{EUT})$$

and

$$P_S = G + P_{in}$$

where:

P_S = effective isotropic radiated power of the substitution antenna (dBm)
P_{in} = power input to the substitution antenna (dBm)
G = gain of the substitution antenna (dBi)
E_S = field strength the substitution antenna (dBm) at eirp P_S
E_{EUT} = field strength measured from the EUT

Where necessary the effective isotropic radiated power is converted to effective radiated power by subtracting the gain of a dipole (2.2dBi) from the eirp value.

Appendix A Test Equipment Calibration Data

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Spurious Emissions, 30 - 5000 MHz, 08-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #5, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 5 (FACT-5)	WC055567	10/9/2019	10/9/2022
Hewlett Packard	Spectrum Analyzer (Blue)	8564E	WC055592	12/2/2020	12/2/2021
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	WC064416	8/19/2021	8/19/2022
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	WC064463	7/7/2020	7/7/2022
Radiated Emissions, 30 - 3,000 MHz, 11-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #7, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 7 (FACT-5)	WC055569	9/15/2019	9/15/2022
Hewlett Packard	Spectrum Analyzer (Blue)	8564E	WC055592	12/2/2020	12/2/2021
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	WC064416	8/19/2021	8/19/2022
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	WC064454	6/7/2021	9/22/2023
Hewlett Packard	9KHz-1300MHz pre-amp	8447F	WC064718	12/7/2020	12/7/2021
EMCO	Antenna, Horn, 1-18 GHz	3115	WC064725	8/17/2021	8/17/2023
Rohde & Schwarz	EMI Test Receiver, 20Hz-7GHz	ESIB 7	WC064989	11/16/2020	11/16/2021
Radiated Emissions, 30 - 5,000 MHz, 20-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #5, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 5 (FACT-5)	WC055567	10/9/2019	10/9/2022
Hewlett Packard	Spectrum Analyzer (Blue)	8564E	WC055592	12/2/2020	12/2/2021
EMCO	Antenna, Horn, 1-18 GHz	3115	WC064725	8/17/2021	8/17/2023
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	WC068124	12/2/2020	12/2/2021
Substitutions, 22-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #5, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 5 (FACT-5)	WC055567	10/9/2019	10/9/2022
Hewlett Packard	Spectrum Analyzer (Purple)	8564E	WC055660	9/20/2021	9/20/2022
EMCO	Horn Antenna, 1-18 GHz (SA40-Purple)	3115	WC062583	7/13/2020	7/13/2022
EMCO	Antenna, Horn, 1-18 GHz	3115	WC064432	12/21/2020	12/21/2022

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	WC064499	6/18/2021	6/18/2022
Rohde & Schwarz	Power Sensor, 1 nW-20 mW, 10 MHz-18 GHz, 50ohms	NRV-Z1	WC064543	11/10/2020	11/10/2021
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	WC064574	3/2/2021	3/2/2022
Rohde & Schwarz	Signal Generator 100kHz - 12.75GHz	SMB 100A	WC068098	9/9/2021	9/9/2022
Antenna Port, 22-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
National Technical Systems	NTS Mask Software (rev 3.9)	N/A	WC022701	N/A	
National Technical Systems	NTS Capture Analyzer Software (rev 4.0)	N/A	WC022706	N/A	
Agilent Technologies	PSA Spectrum Analyzer	E4446A	WC055670	8/17/2021	8/31/2022
Unknown	20dB Attenuator	18n50w-20fm	WC068107	N/A	
Radiated Emissions, 30 - 1,000 MHz & Substitutions, 27-Oct-21					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	WC022452	N/A	
ETS-Lindgren	EMC Chamber #7, Inner Dimensions (LxWxH): 24' x 38' x 20'	CH 7 (FACT-5)	WC055569	9/15/2019	9/15/2022
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	WC064454	6/7/2021	9/22/2023
Rohde & Schwarz	EMI Test Receiver, 20Hz-40GHz	ESI	WC068000	6/23/2021	6/23/2022
Com-Power	RF Preamplifier	PAM-103	WC072429	10/26/2021	10/26/2022
Compliance Design	Tuned Dipole Antenna	Roberts (400-1000MHz)	WC064523	6/23/2020	6/23/2022
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	WC064499	6/18/2021	6/18/2022
Rohde & Schwarz	Power Sensor, 1 nW-20 mW, 10 MHz-18 GHz, 50ohms	NRV-Z1	WC064543	11/10/2020	11/10/2021
Rohde & Schwarz	Signal Generator 100kHz - 12.75GHz	SMB 100A	WC068098	9/9/2021	9/9/2022

Appendix B Test Data

TL147289-RA Pages 21 – 40

Client:	GE MDS LLC	PR Number:	PR147289
Product	LN400	T-Log Number:	TL147289-RA
System Configuration:	Module	Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Emissions Standard(s):	FCC Part 90, ISEDC RSS-119	Class:	-
Immunity Standard(s):	-	Environment:	Industrial Radio

EMC Test Data

For The

GE MDS LLC

Product

LN400

Date of Last Test: 10/27/2021

Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

RSS-119 and FCC Part 90

Power, Unwanted Emissions, Occupied Bandwidth

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

Temperature: 21-23 °C

Rel. Humidity: 42-45 %

Summary of Results

Run #	Spacing	Data Rate	Test Performed	Limit	Pass / Fail	Result / Margin
1	-	-	Output Power	Determined at time of Licensing	Pass	41.3 dBm
2	6.25 kHz, 12.5 kHz, 25.0 kHz	4.8, 9.6, 10.0, 16.0, 20.0 ksps	Spectral Mask and ACP	Masks C, D, E, Y (IC) and ACP (FCC) limits	Pass	All within limits
3	6.25 kHz, 12.5 kHz, 25.0 kHz	4.8, 9.6, 10.0, 16.0, 20.0 ksps	99% or Occupied Bandwidth	6, 11.25, 20 and 22 kHz	Pass	5.1 kHz, 10.4 kHz, 10.7 kHz, 17.1 kHz, 21.5 kHz
4	6.25 kHz	4.8 ksps	Spurious Emissions (conducted)	-25 dBm	Pass	All < -25 dBm
5	6.25 kHz	4.8 ksps	Spurious emissions (radiated)	-25 dBm ERP	Pass	-28.8 dBm @ 1410 MHz (-3.8 dBm)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Note

Sample S/N: 3696416 (conducted tests) 3696417 (radiated tests)

Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

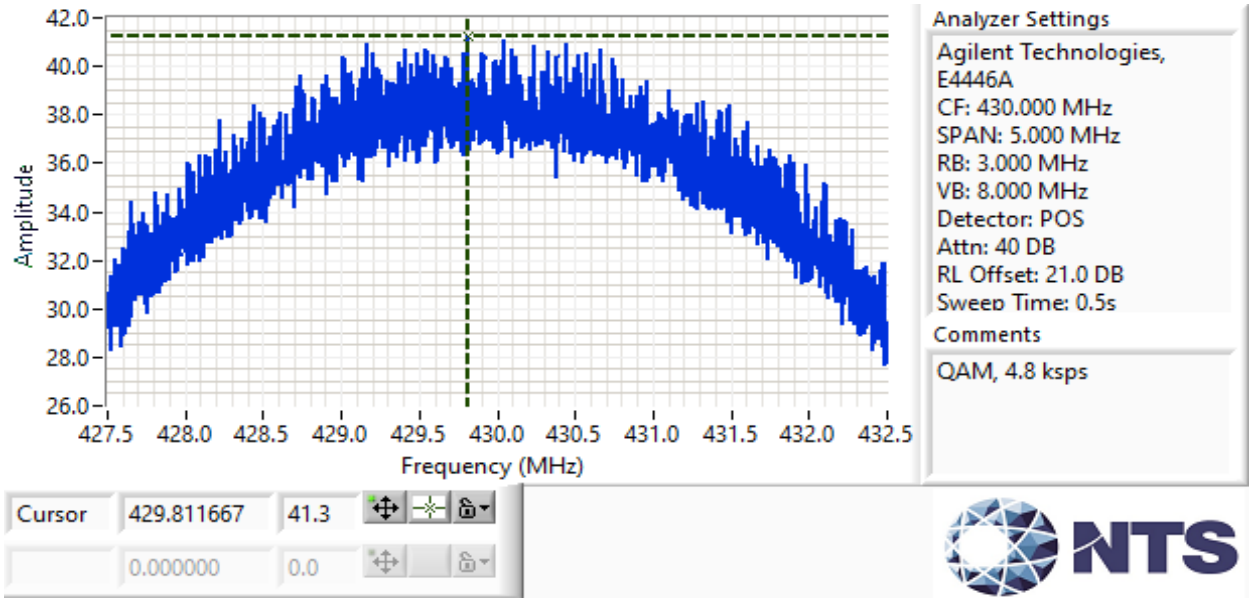
Run #1: Output Power

Date of Test: 10/122/2021 Config. Used: 2
Test Engineer: David Bare Config Change: None
Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

Cable Loss: 0.0 dB Attenuator: 21.0 dB Total Loss: 21.0 dB
Cable ID(s): - Attenuator IDs: WC68107

Power Setting[2]	Frequency (MHz)	Output Power (dBm) [1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W
40	406.1	41.1	12882.5	16.5	Pass	57.6	575.440
40	430	41.3	13489.6	16.5	Pass	57.8	602.560
40	470	41.0	12589.3	16.5	Pass	57.5	562.341

Note 1:	Output power measured using a spectrum analyzer (see plots below) with RBW=3 MHz, VB=8 MHz, peak detector
Note 2:	Power setting - the software power setting used during testing, included for reference only.
Note 3:	Baud rate and modulation type do not have significant effect to the measured power level.



Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Run #2: Spectral Mask, FCC Part 90 Masks C, D, E, Y (RSS-119) and ACP (FCC 90.221)

Date of Test: 10/22/2021 Config. Used: 2

Test Engineer: David Bare Config Change: None

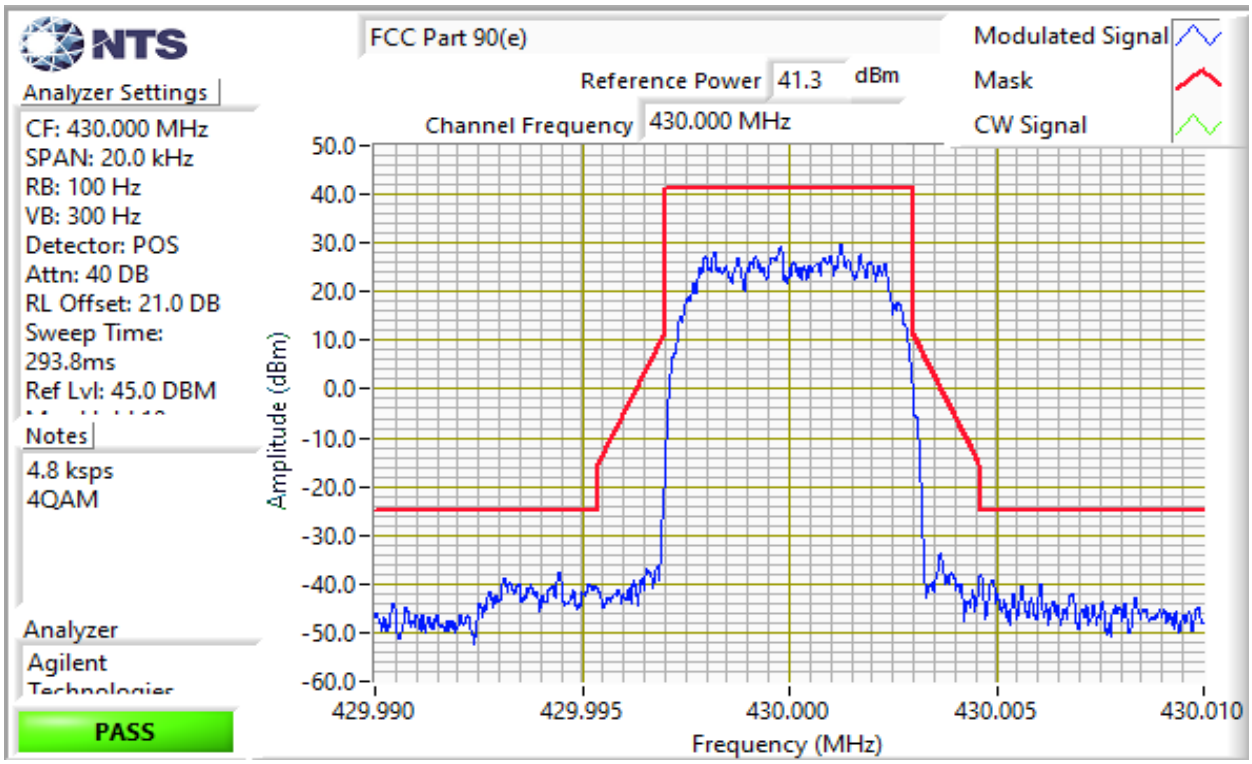
Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

Note 1:	430 MHz peak power measurements were used as a spectral mask power reference.
Note 2:	4QAM modulation has the worst case spectral mask results at 6.25 kHz BW of operations hence 4QAM was used for 12.5 kHz (9.6 ksps and 10 ksps) and 25 kHz (16 ksps and 20 ksps) BW of operations.

Modulations = 4QAM, 16QAM, 64QAM

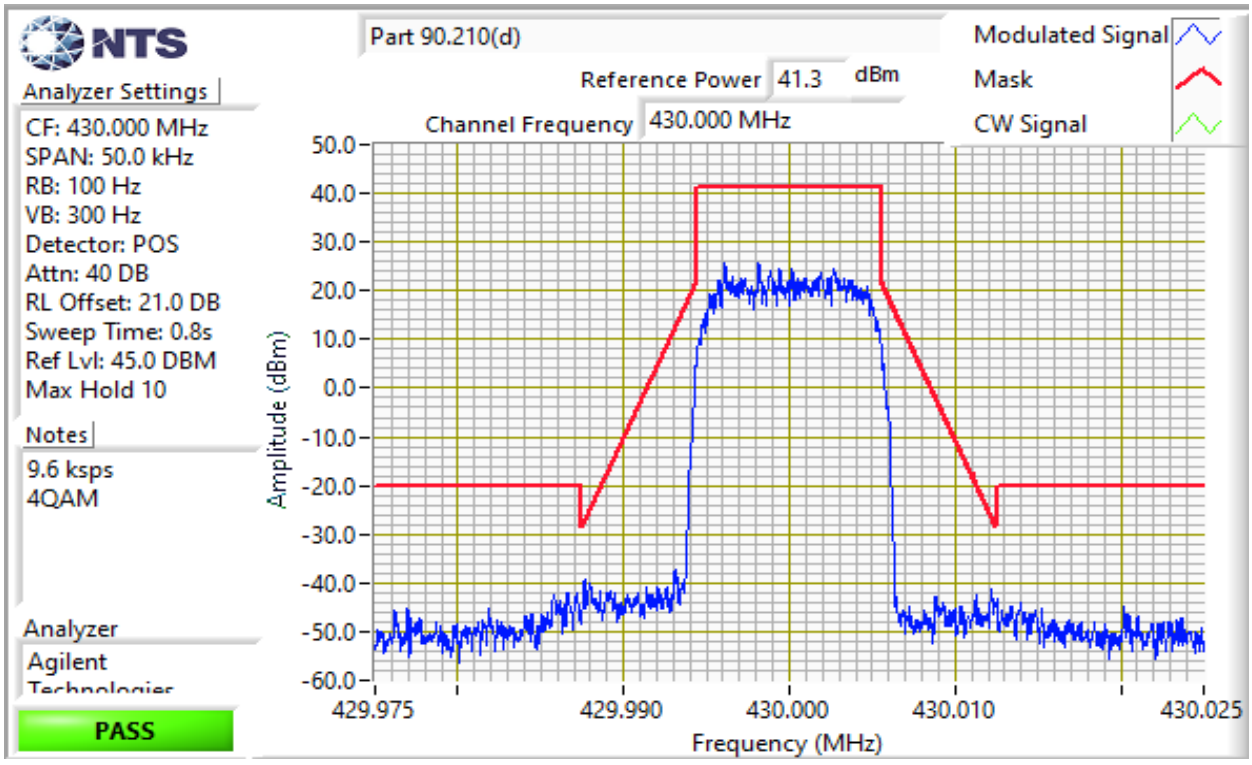
20 ksps is for 450 MHz to 470 MHz operations only. (EUT does not operate with 20 ksps in 406.1 - 430 MHz range)

4.8 ksps: 6.25 kHz BW (Mask E)

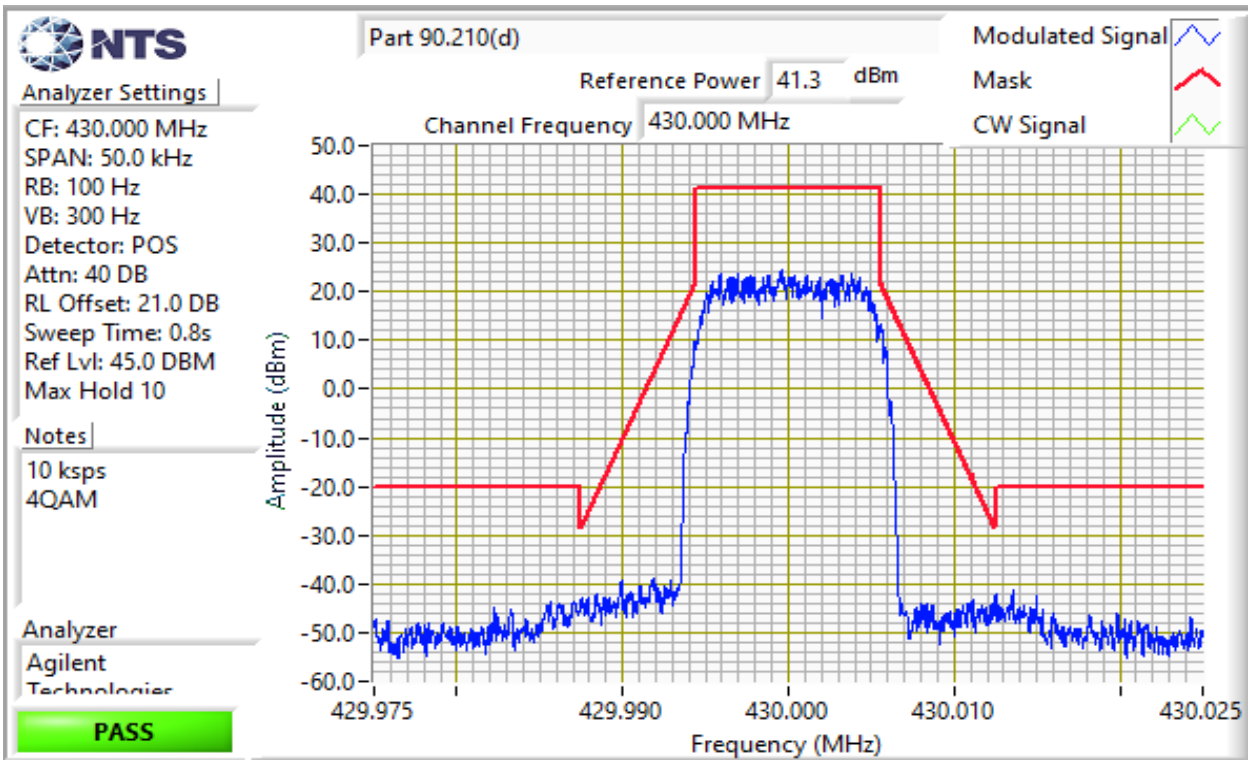


Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

9.6 ksps and 10 ksps: 12.5 kHz BW (Mask D)

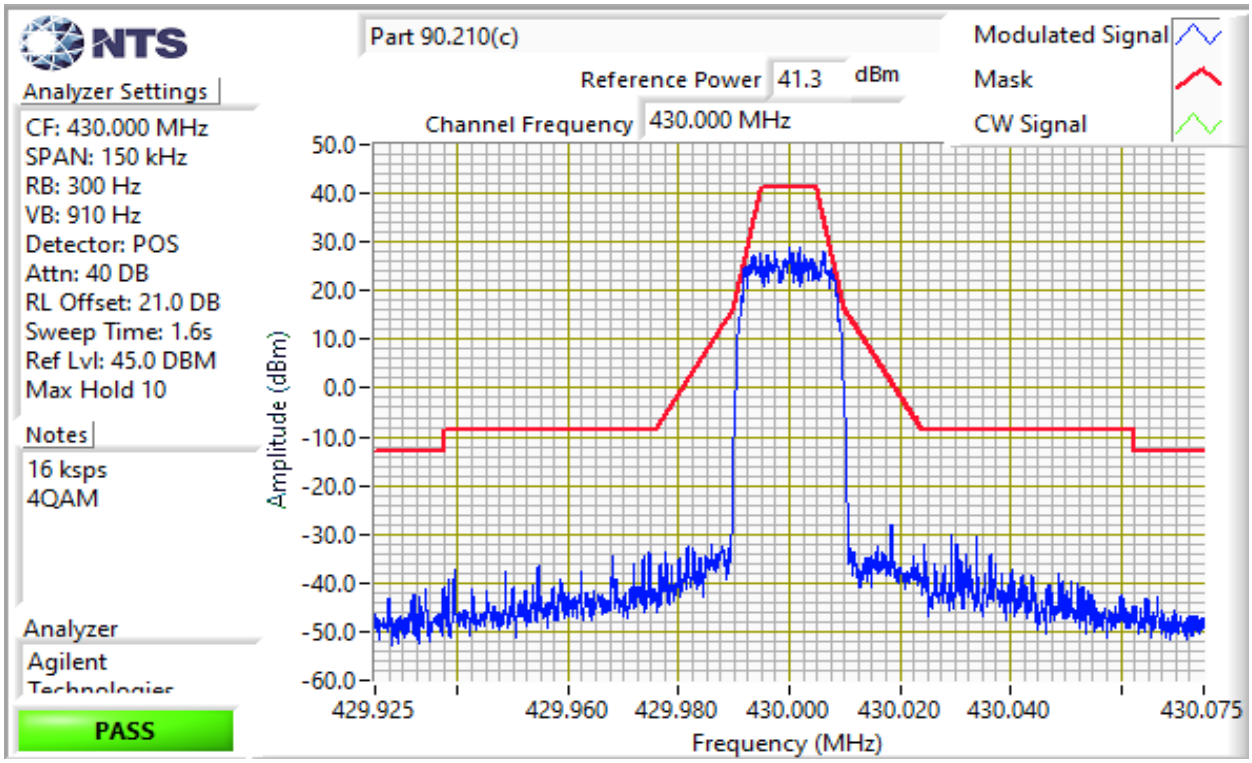


Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A



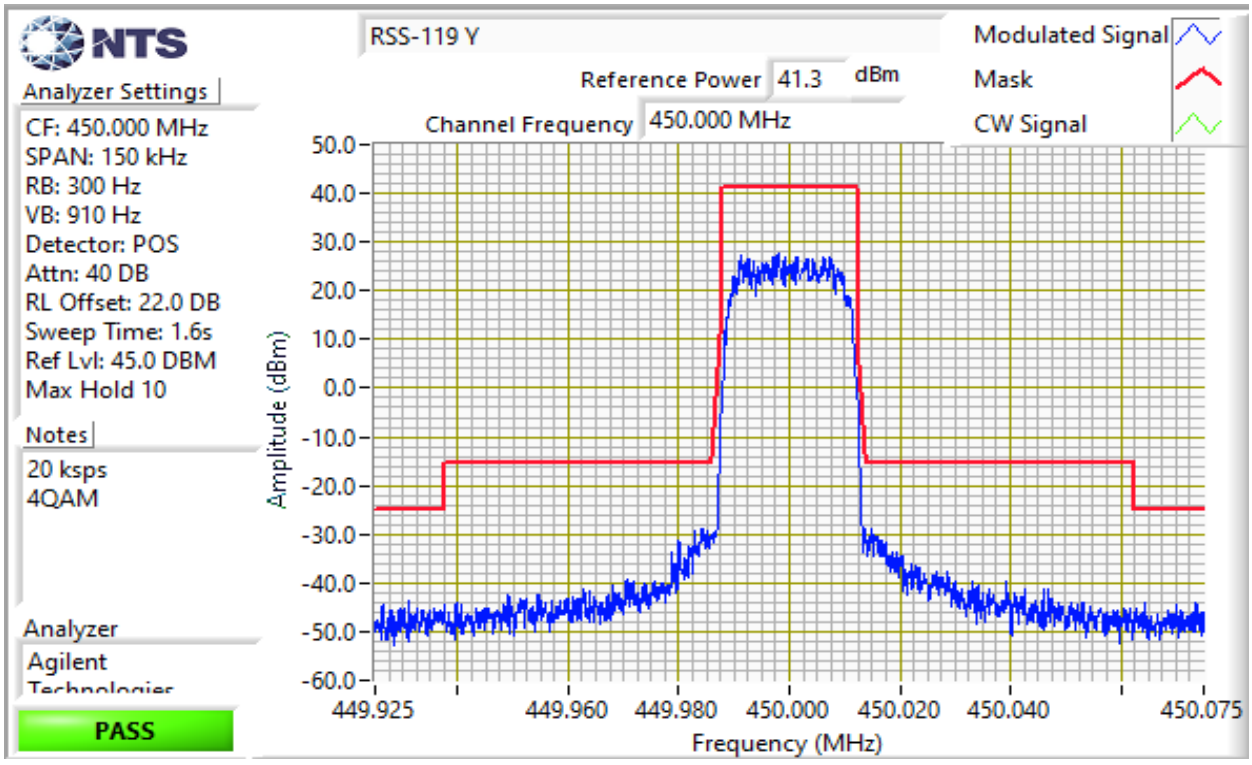
Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

16 ksps: 25 kHz BW (Mask C)



Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

RSS-119 20 ksps: >20 kHz BW (Mask Y)

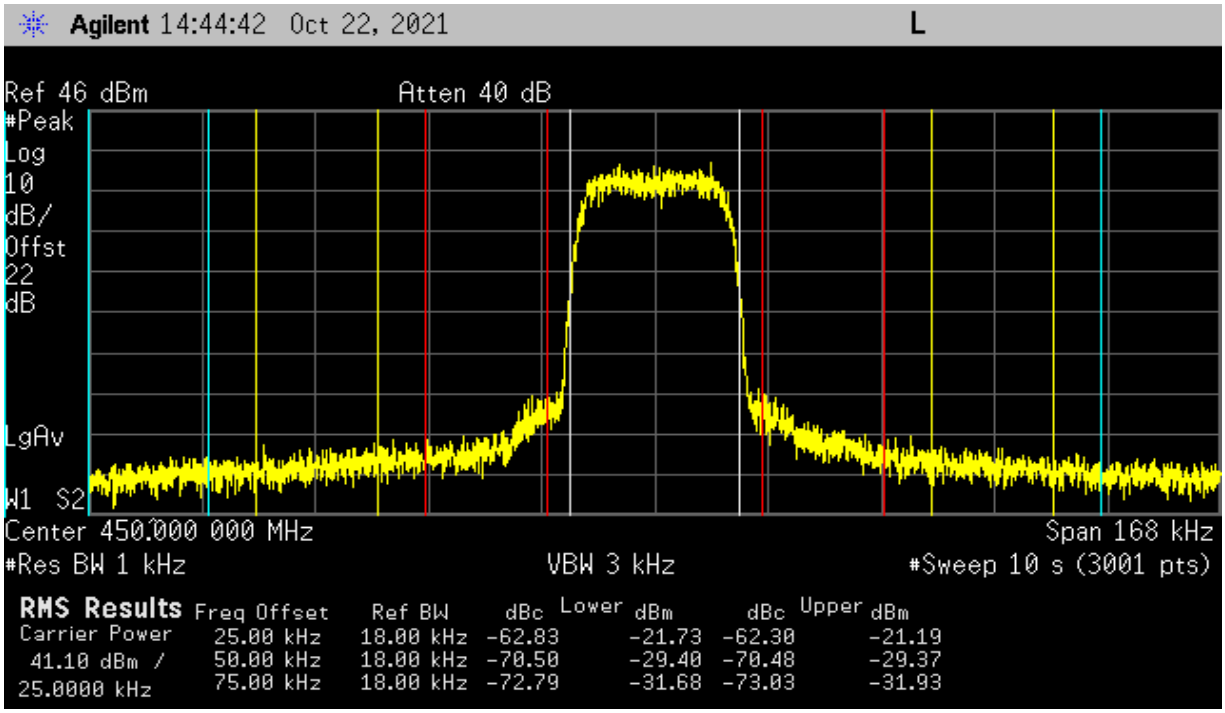


Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

FCC part 90.221 ACP for 22 kHz Occupied Bandwidth operations
Carrier frequency: 430.0000 MHz 20.0 ksps, 4QAM

Frequency offset	Adjacent channel frequency (MHz)	Measured adjacent channel power			Limit (dBc)	Margin (dBm)	Result
		Adj. power (dBm) [1]	Tx power (dBm)	Adj. power (dBc)			
-25 kHz	-0.0250	-21.7	41.1	-62.8	-60.0	-2.8	Pass
+25 kHz	0.0250	-21.2	41.1	-62.3	-60.0	-2.3	Pass
-50 kHz	-0.0500	-29.4	41.1	-70.5	-70.0	-0.5	Pass
+50 kHz	0.0500	-29.4	41.1	-70.5	-70.0	-0.5	Pass
-75 kHz	-0.0750	-31.7	41.1	-72.8	-70.0	-2.8	Pass
+75 kHz	0.0750	-31.9	41.1	-73.0	-70.0	-3.0	Pass

Note 1:	Adjacent channel power measured using a spectrum analyzer (see plots below) with RBW: 1 kHz, VB: 3 kHz, peak detector. Adjacent channel Integrated power calculated over 18 kHz measurement bandwidth.
Note 2:	4QAM modulation has the worst case spectral mask results hence 4QAM was used for adjacent channel power measurements.
Note 3:	Measurements were performed with peak detector but the title of result table in the spectrum analyzer indicates "RMS Results" which is not the case. The results are peak power.



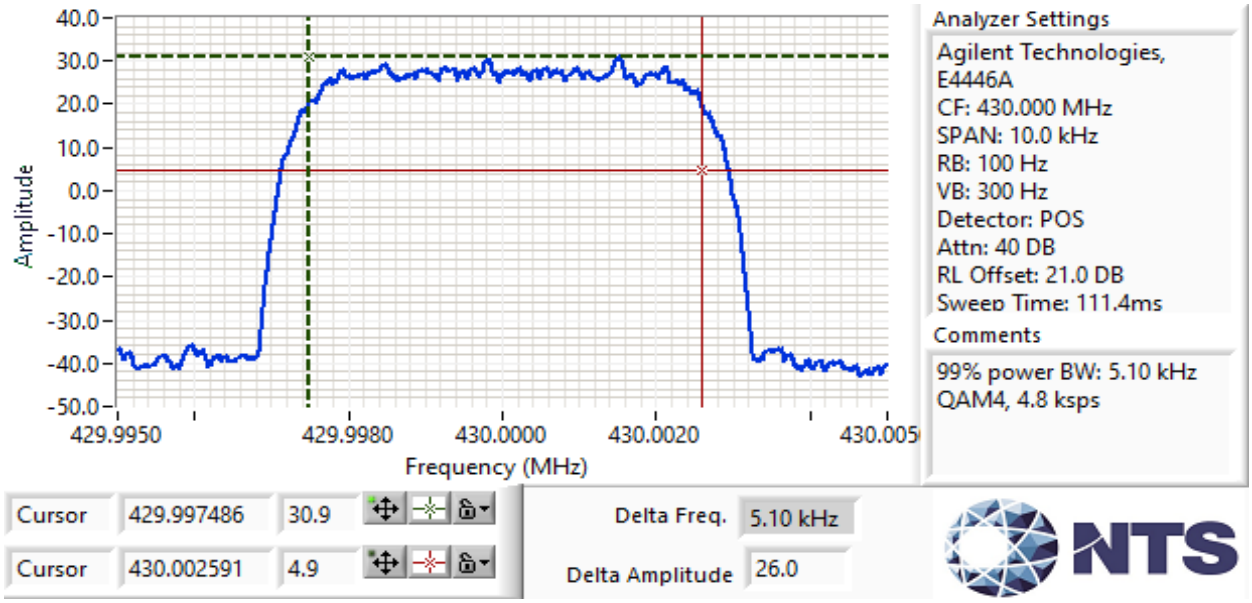
Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Run #3: Signal Bandwidth

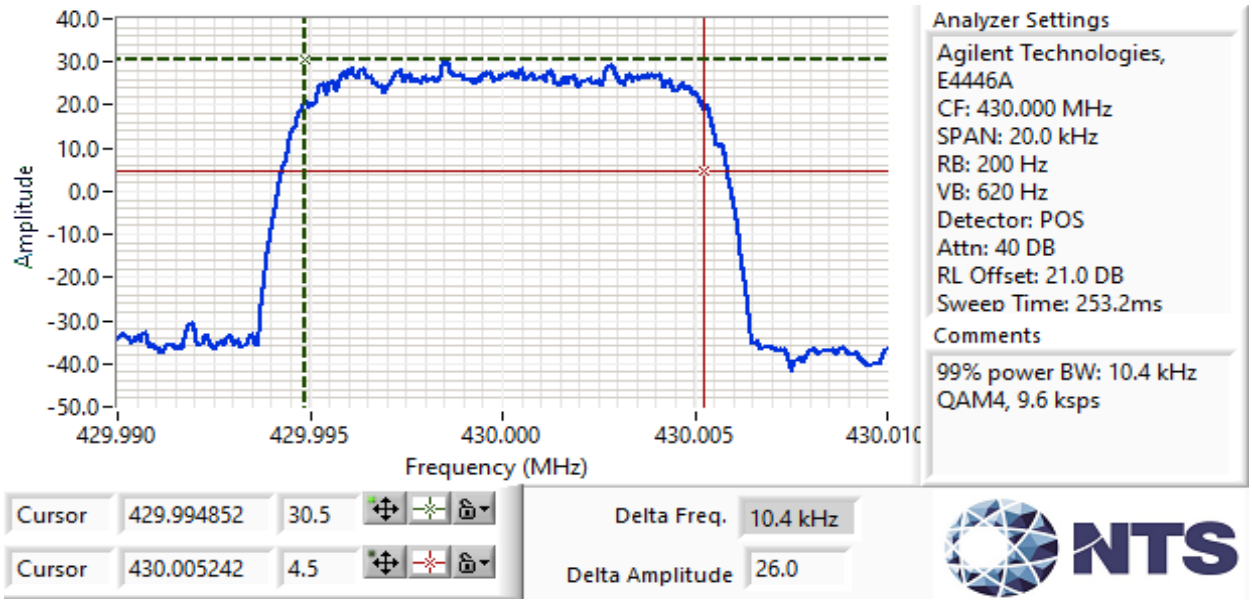
Date of Test: 10/22/2021 Config. Used: 2
Test Engineer: David Bare Config Change: None
Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

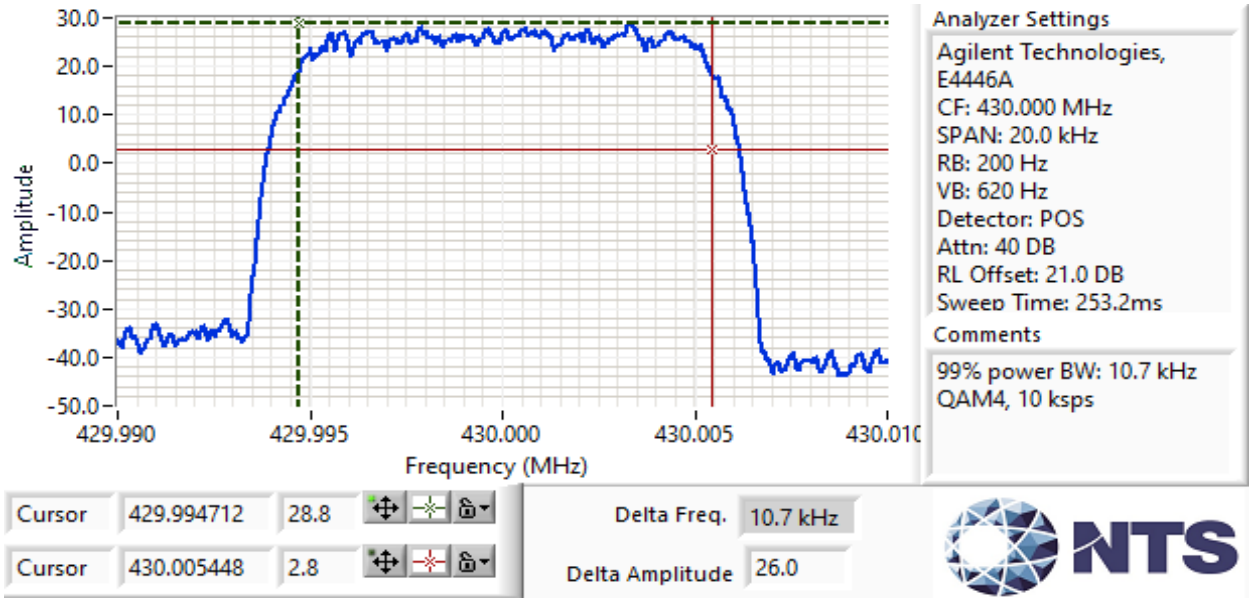
Power Setting	Baud rate (ksps)	Frequency (MHz)	RBW (kHz)	OBW (kHz)	
				26dB	99%
40	4.8	430.0000	0.1		5.10
40	9.6	430.0000	0.2		10.40
40	10.0	430.0000	0.2		10.70
40	16.0	430.0000	0.2		17.10
40	20.0	450.0000	0.3		21.50

Note 1:	99% bandwidth measured in accordance with ANSI C63.10, with RB between 1% and 5% of the measured bandwidth and VB ≥ 3*RB and Span ≥ 1.5% and ≤ 5% of measured bandwidth.

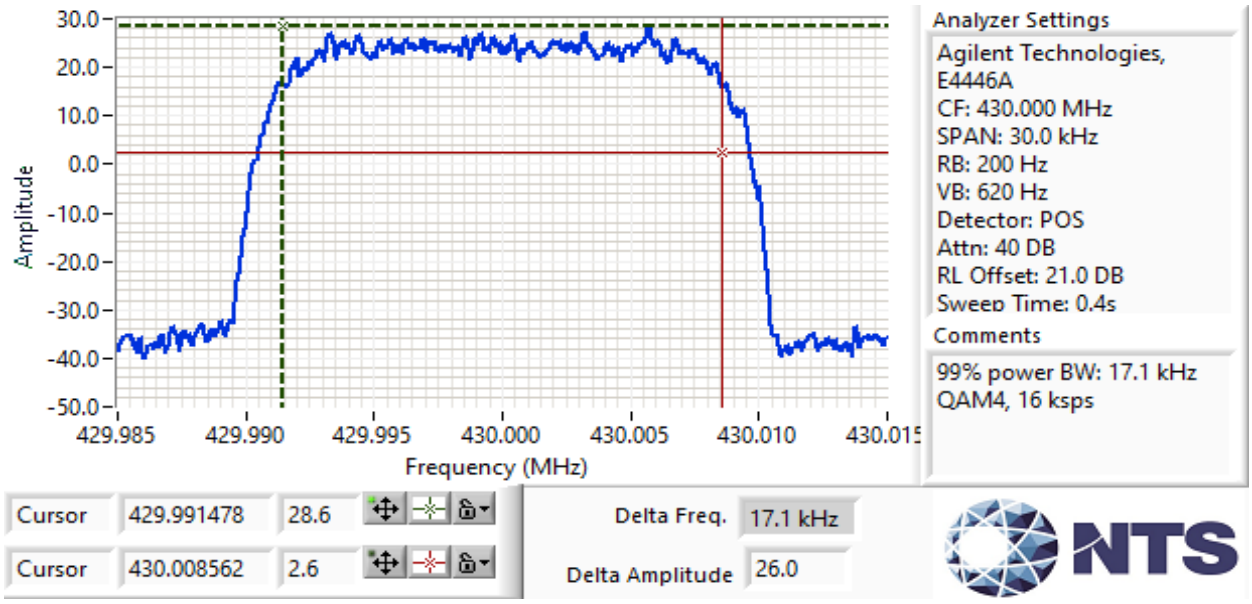


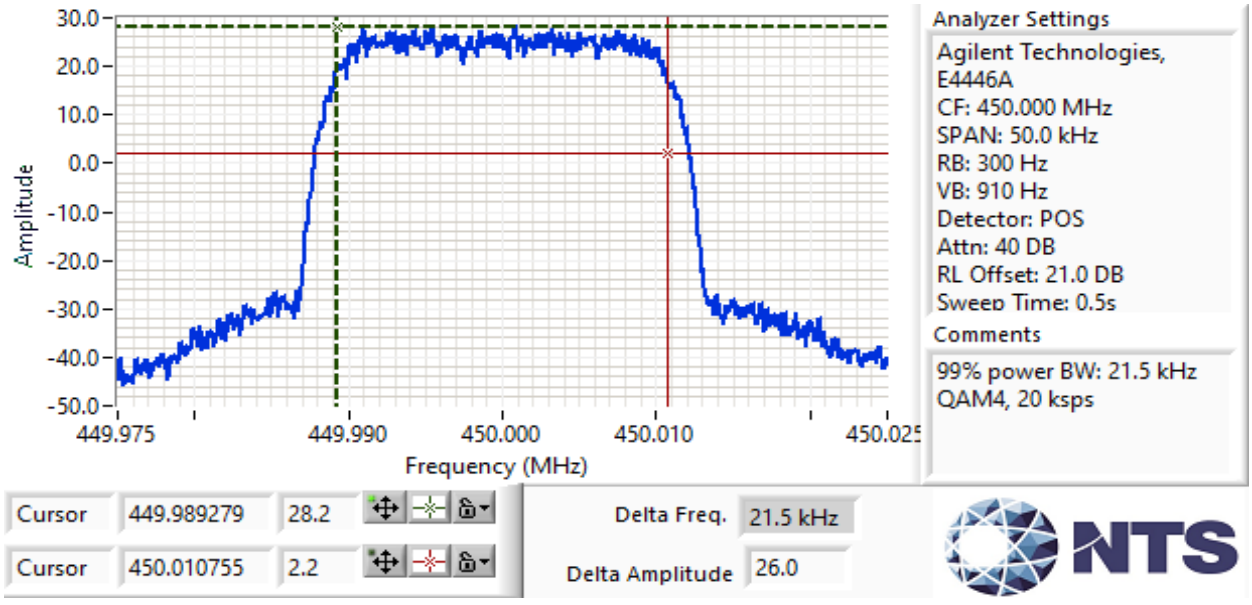
Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A





Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A





Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Run #4: Out of Band Spurious Emissions, Conducted

Date of Test: 10/22/2021 Config. Used: 2

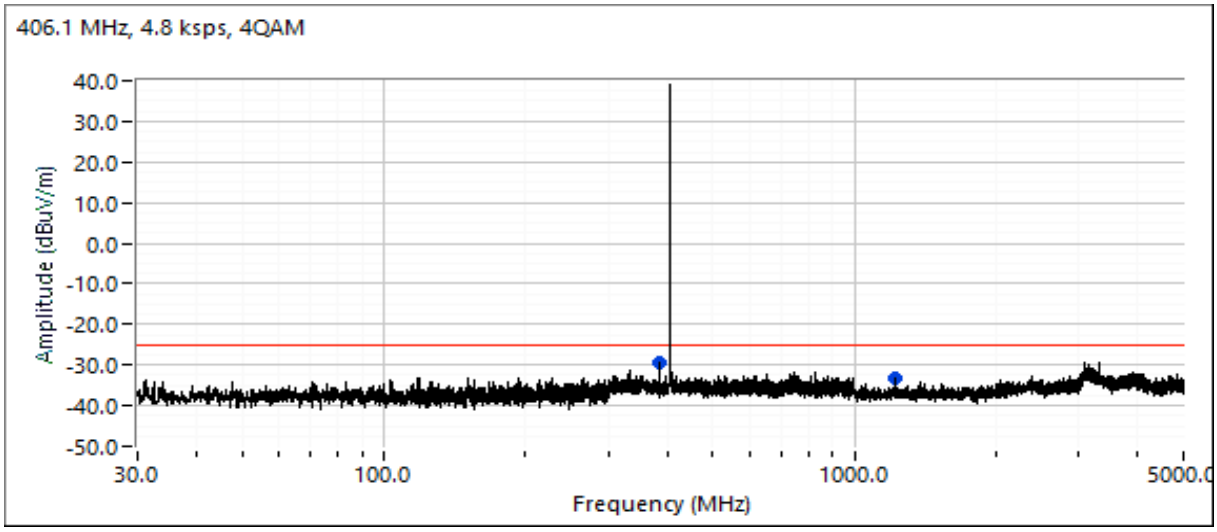
Test Engineer: David Bare Config Change: None

Test Location: Fremont EMC Lab #4B EUT Voltage: 13.8 VDC

Frequency (MHz)	Limit	Result
406.1	-25 dBm	Pass
430	-25 dBm	Pass
470	-25 dBm	Pass

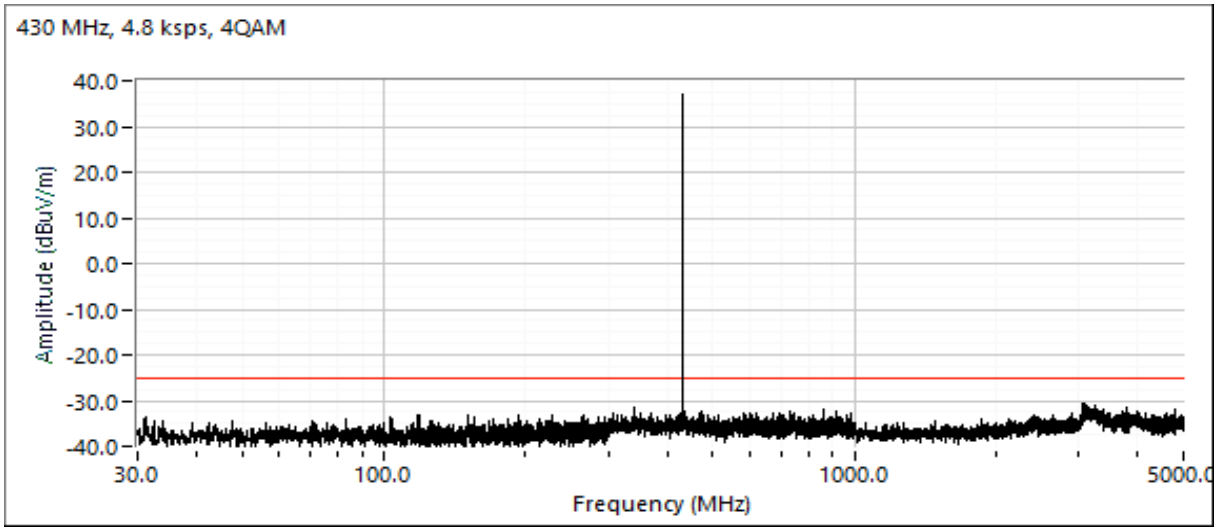
Note 1:	The spectrum analyzer settings for out-of-band spurious emissions; RBW: 100 kHz, VBW: 300 kHz for frequencies below 1 GHz, RBW: 1 MHz, VBW: 3 MHz for frequencies above 1 GHz.
Note 2:	A high pass filter used above 1 GHz measurements.
Note 3:	Transmitter set to 6.25 kHz BW mode as a worst case which has the lowest BW and highest power spectral density.
Note 4:	The limit is taken from FCC Part 90.210 Mask E (RSS-119 Mask E)

Plots for low channel, power setting(s) = 40

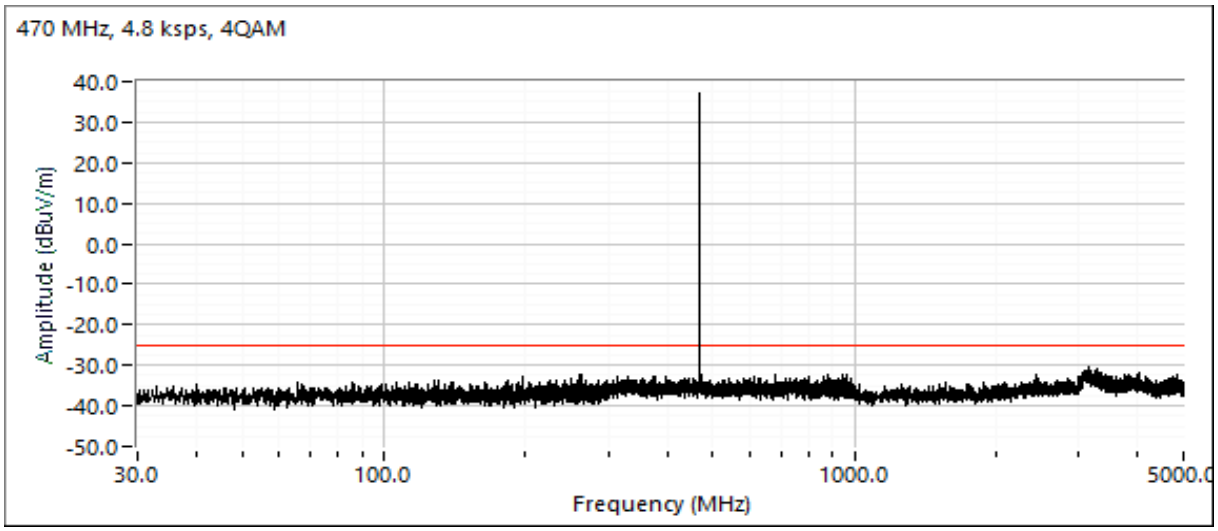


Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Plots for center channel, power setting(s) = 40



Plots for high channel, power setting(s) = 40



Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Run #5: Out of Band Spurious Emissions, Radiated

Date of Test: 10/20 & 10/27/2021 Config. Used: 1
Test Engineer: John Caizzi & David Bare Config Change: none
Test Location: Fremont Chamber 5 & 7 EUT Voltage: 5.25 & 13.8 VDC

Run #5a - Preliminary measurements - chamber scans

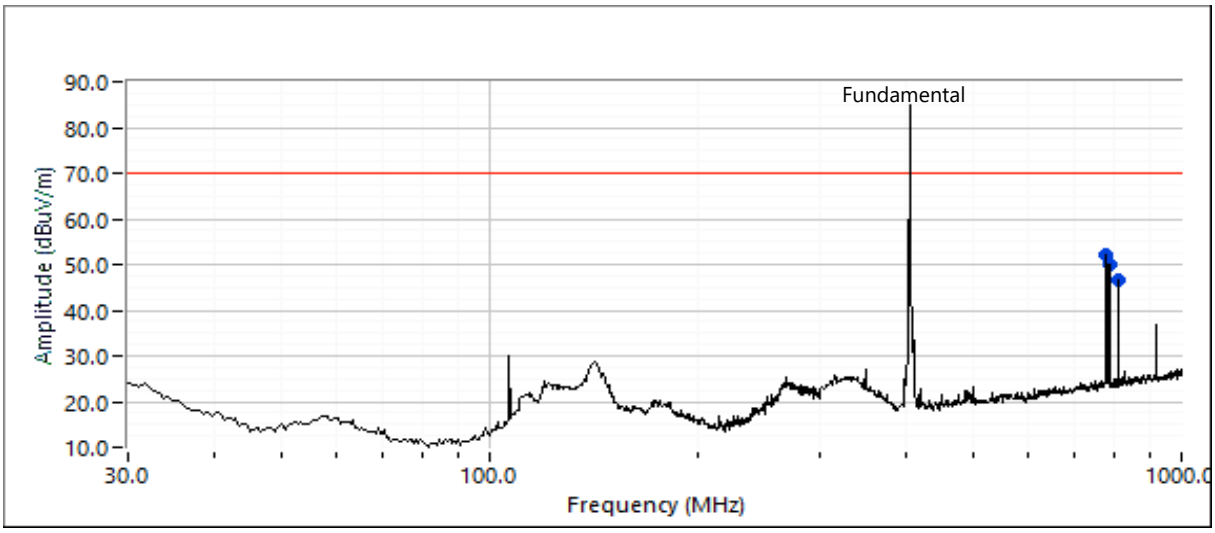
Conducted limit (dBm): -25 The limit is taken from FCC Part 90 Mask E
Approximate field strength limit @ 3m: 70.2

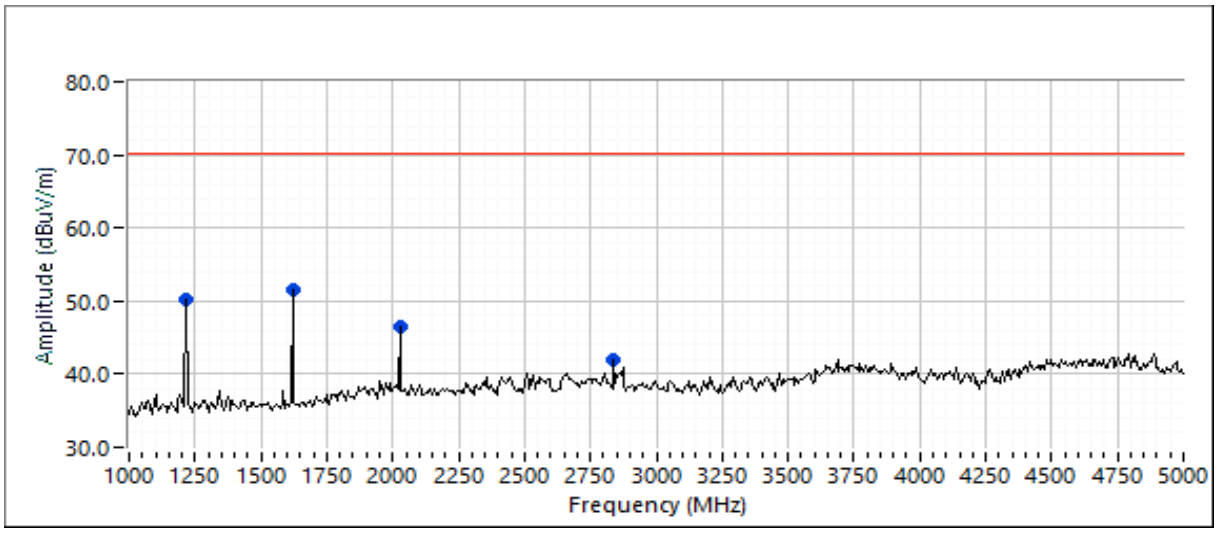
Frequency	Level	Pol	FCC 90.210		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
779.409	52.1	V	70.2	-18.1	Peak	308	1.5	Transient	*406.1*
785.851	50.2	V	70.2	-20.0	Peak	303	1.5	Transient	*406.1*
812.200	46.5	H	70.2	-23.7	Peak	74	1.0		*406.1*
1213.330	*50.1*	*H*	*70.2*	*-20.1*	*Peak*	*315*	*1.0*		*406.1*
1620.000	*51.5*	*V*	*70.2*	*-18.7*	*Peak*	*213*	*1.5*		*406.1*
2026.670	*46.6*	*V*	*70.2*	*-23.6*	*Peak*	*112*	*2.0*		*406.1*
2840.000	*42.1*	*V*	*70.2*	*-28.1*	*Peak*	*295*	*2.5*		*406.1*
860.003	51.4	H	70.2	-18.8	Peak	54	1.0		430
920.015	36.6	H	70.2	-33.6	Peak	270	3.5	Transient	430
1290.000	51.2	V	70.2	-19.0	Peak	254	2.2		430
1308.980	53.5	V	70.2	-16.7	Peak	158	1.9		430
1720.000	52.1	V	70.2	-18.1	Peak	12	1.3		430
2916.010	50.3	V	70.2	-19.9	Peak	160	1.3		430
3738.450	51.7	V	70.2	-18.5	Peak	160	1.3		430
911.396	35.7	H	70.2	-34.5	Peak	331	4.0	Transient	470
940.003	43.5	H	70.2	-26.7	Peak	100	1.0		470
1406.670	*60.2*	*H*	*70.2*	*-10.0*	*Peak*	*96*	*1.5*		*470*
1873.330	*45.0*	*H*	*70.2*	*-25.2*	*Peak*	*245*	*1.5*		*470*

Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

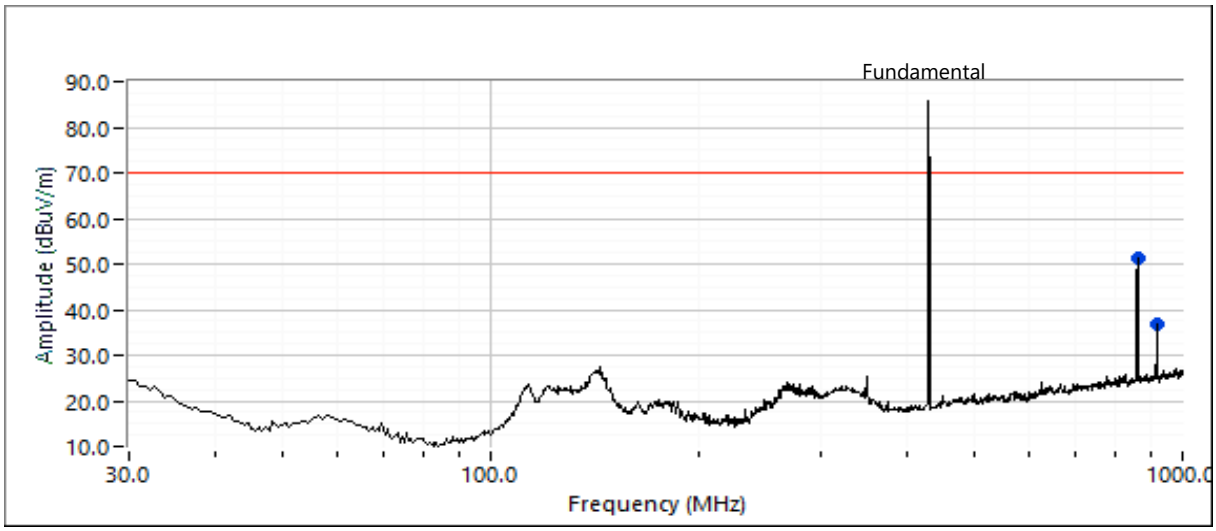
Low channel, 406.1 MHz, 4QAM, 4.8 ksps, power setting = max

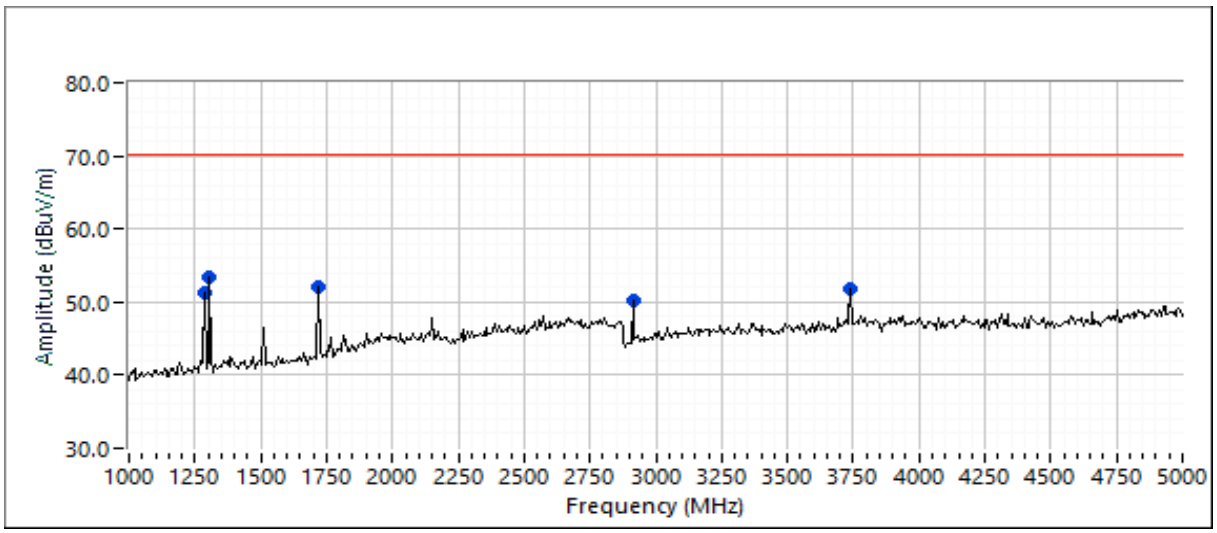




Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

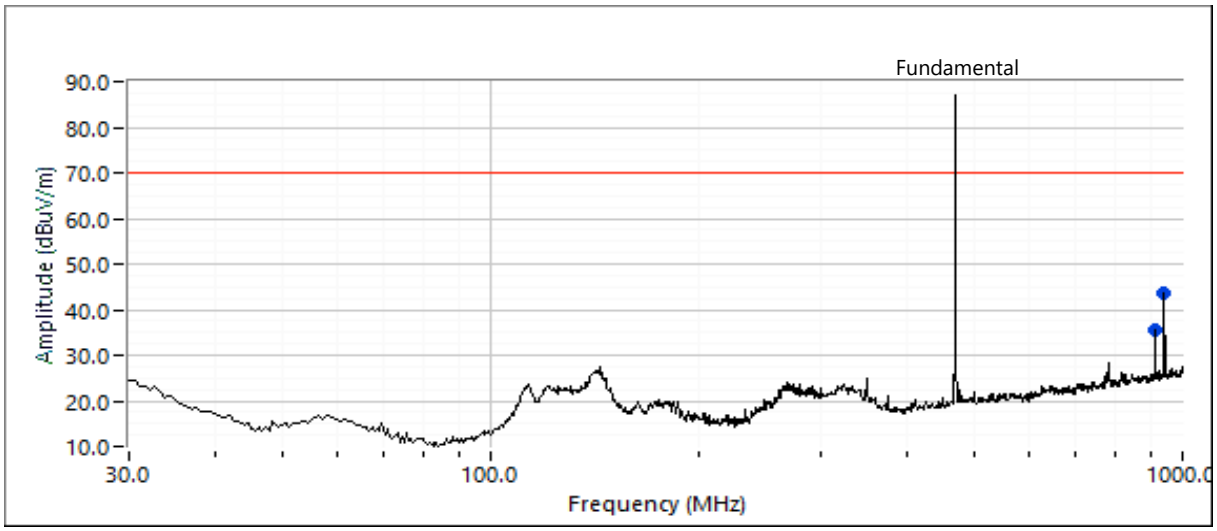
Center channel, 430 MHz, 4QAM, 4.8 ksps, power setting = max

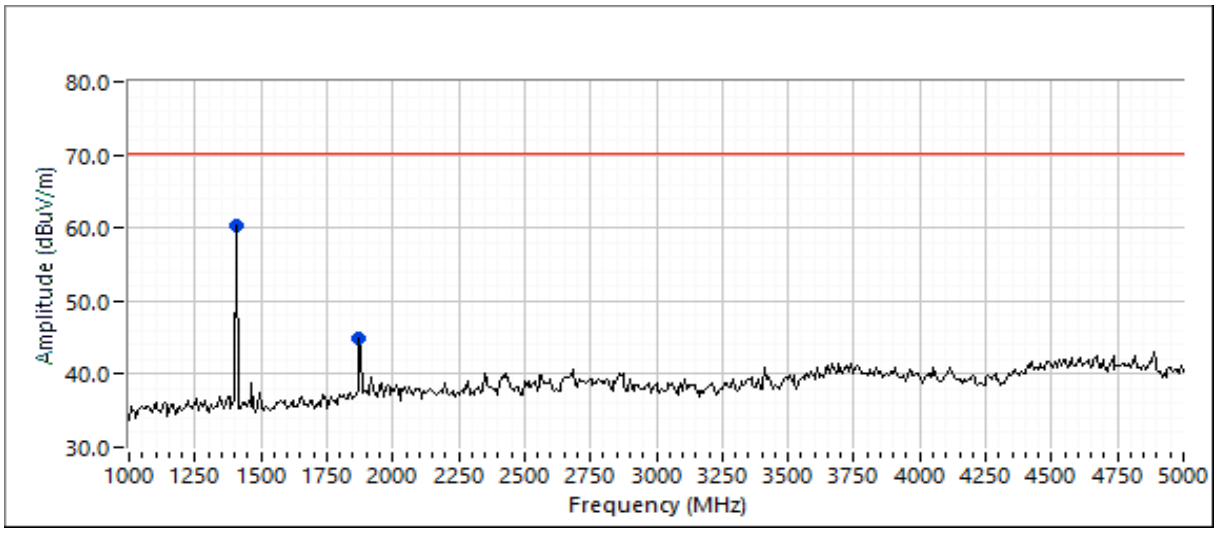




Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

High channel, 470 MHz, 4QAM, 4.8 ksps, power setting = max





Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Run #5b: - Final EUT Field Strength Measurements and Substitution Measurements

Date of Test: 10/20, 10/22 & 10/27/2021 Config. Used: 1
Test Engineer: John Caizzi & David Bare Config Change: none
Test Location: Fremont Chamber 5 & 7 EUT Voltage: 5.25 & 13.8 VDC

EUT Field Strength

Frequency	Level	Pol	FCC 90.210		Detector	Azimuth	Height	Comments	Channel
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters		
812.220	55.9	H	70.2	-14.3	PK	75	1.0	RB 100kHz; VB: 300kHz	406.1
1218.410	54.8	H	70.2	-15.4	PK	195	1.28	RB 1 MHz;VB 3 MHz;Pe	406.1
1624.420	53.8	V	70.2	-16.4	PK	206	2.50	RB 1 MHz;VB 3 MHz;Pe	406.1
2033.150	53.2	V	70.2	-17.0	PK	129	2.05	RB 1 MHz;VB 3 MHz;Pe	406.1
2841.030	41.9	V	70.2	-28.3	PK	296	2.37	RB 1 MHz;VB 3 MHz;Pe	406.1
860.000	55.2	H	70.2	-15.0	PK	54	1.02	RB 100kHz; VB: 300kHz	430
1290.000	57.1	V	70.2	-13.1	PK	255	2.20	RB 1 MHz;VB 3 MHz;Pe	430
1307.760	40.7	V	70.2	-29.5	PK	158	1.69	RB 1 MHz;VB 3 MHz;Pe	430
1720.000	52.2	V	70.2	-18.0	PK	10	1.31	RB 1 MHz;VB 3 MHz;Pe	430
2917.230	42.3	V	70.2	-27.9	PK	160	1.46	RB 1 MHz;VB 3 MHz;Pe	430
3739.340	52.7	V	70.2	-17.5	PK	149	1.30	RB 1 MHz;VB 3 MHz;Pe	430
940.003	45.9	H	70.2	-24.3	PK	95	1.0	RB 100kHz; VB: 300kHz	470
1409.710	69.3	H	70.2	-0.9	PK	105	1.48	RB 1 MHz;VB 3 MHz;Pe	470
1879.540	49.2	H	70.2	-21.0	PK	211	1.45	RB 1 MHz;VB 3 MHz;Pe	470

Note 1:	The field strength limit in the tables above was calculated from the erp/eirp limit detailed in the standard using the free space propagation equation: E=√(30PG)/d. This limit is conservative - it does not consider the presence of the ground plane and, for erp limits, the dipole gain (2.2dBi) has not been included. The erp or eirp for all signals with less than 20dB of margin relative to this field strength limit is determined using substitution measurements.
Note 2:	Measurements are made with the antenna port terminated.

Client:	GE MDS LLC	PR Number:	PR147289
Model:	LN400	T-Log Number:	TL147289-RA
		Project Manager:	Christine Krebill
Contact:	Christopher Hughes	Project Engineer:	David Bare
Standard:	FCC Part 90, ISEDC RSS-119	Class:	N/A

Substitution measurements

Horizontal

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
812.220	-41.1	0.7	55.8	96.2	55.9	-40.3	-42.5		-25.0	-17.5
860.000	-41.1	0.7	55.6	96.0	55.2	-40.8	-43.0		-25.0	-18.0
1218.410	-41.6	6.3	61.5	96.8	54.8	-42.0	-44.2		-25.0	-19.2
1409.710	-41.7	7.5	61.7	95.9	69.3	-26.6	-28.8		-25.0	-3.8

Vertical

Frequency	Substitution measurements			Site	EUT measurements			eirp Limit	erp Limit	Margin
MHz	Pin[1]	Gain[2]	FS[3]	Factor[4]	FS[5]	eirp (dBm)	erp (dBm)	dBm	dBm	dB
1624.420	-41.9	8.8	62.8	95.9	53.8	-42.1	-44.3		-25.0	-19.3
2033.150	-42.1	9.1	62.1	95.1	53.2	-41.9	-44.1		-25.0	-19.1
1290.000	-41.7	6.8	62.3	97.2	57.1	-40.1	-42.3		-25.0	-17.3
1720.000	-41.9	8.7	62.7	95.9	52.2	-43.7	-45.9		-25.0	-20.9
3739.340	-43.2	9.4	62.1	95.9	52.7	-43.2	-45.4		-25.0	-20.4

Note 1:	Pin is the input power (dBm) to the substitution antenna
Note 2:	Gain is the gain (dBi) for the substitution antenna (WC064432)
Note 3:	FS is the field strength (dBuV/m) measured from the substitution antenna.
Note 4:	Site Factor - this is the site factor to convert from a field strength in dBuV/m to an eirp in dBm.
Note 5:	EUT field strength as measured during initial run.

End of Report

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